A photograph of a river flowing through a forest. The river is dark and turbulent, with white foam from rapids visible. The banks are rocky and covered with fallen leaves. The forest consists of many bare, thin trees, suggesting a late autumn or winter setting. The lighting is natural, with some sunlight filtering through the trees.

An Assessment of Macroinvertebrate Assemblages in the Marcellus Shale Region of the Susquehanna River Basin

10th National Monitoring Conference

May 5, 2016

Luanne Steffy

Susquehanna River Basin Commission

Susquehanna River

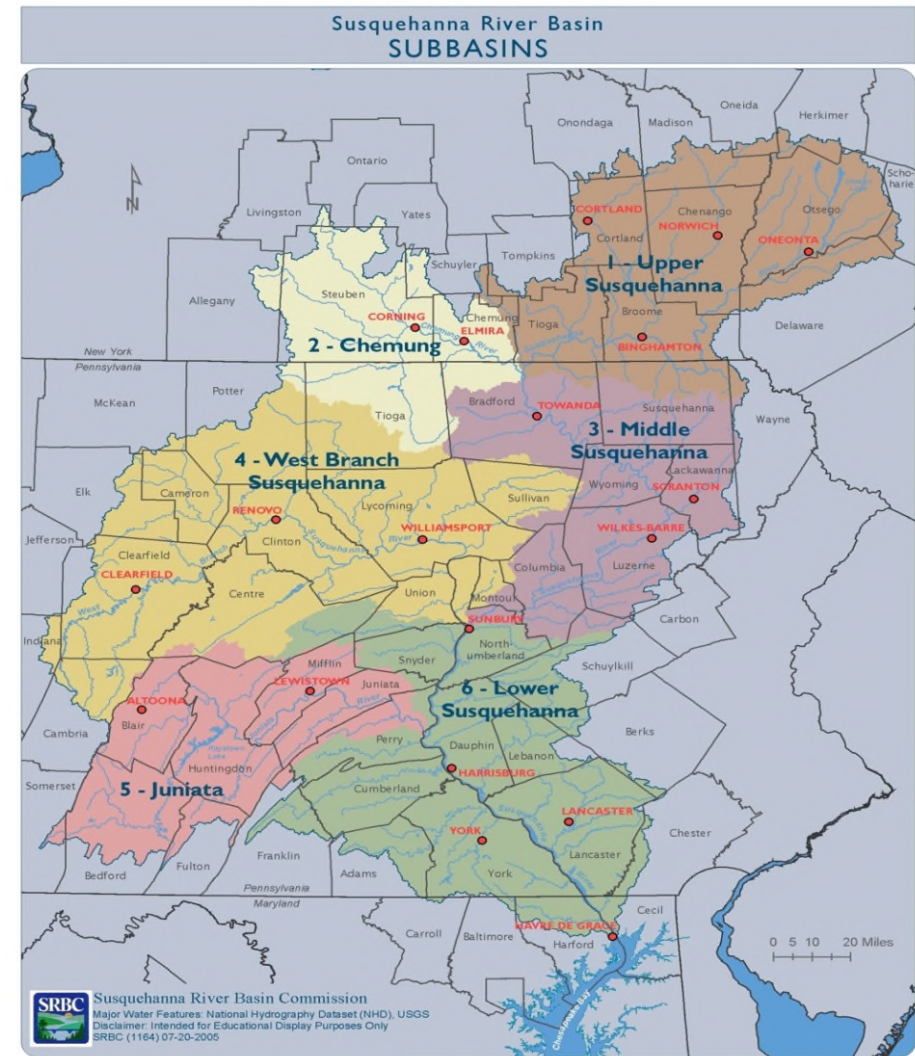
About the Basin and the Commission

Susquehanna River Basin

- 27,510 sq mile watershed
- Comprises 43% of the Chesapeake Bay Watershed
- 60% forested
- 85% of the basin is underlain with natural gas shales

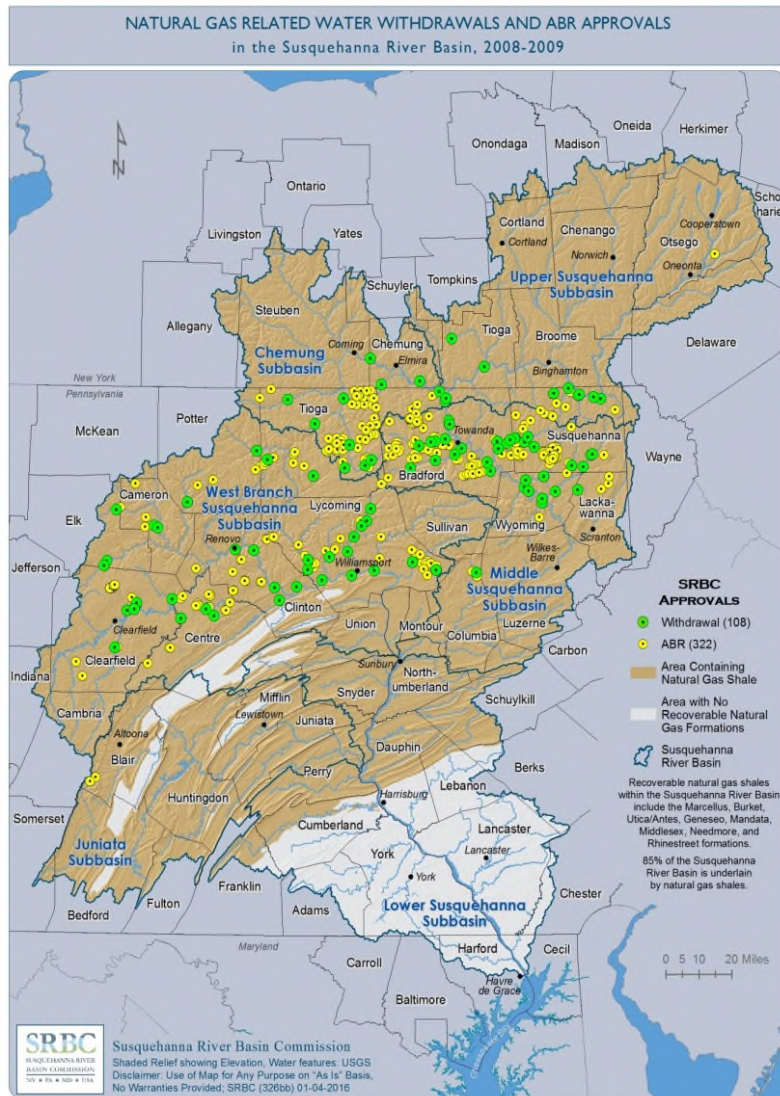
Susquehanna River Basin Commission

- SRBC is a federal-interstate compact commission established in 1971 by the federal government and the states of NY, PA, MD.
- Responsible for managing the basin's water resources
- ~65 employees, 15 fulltime monitoring staff

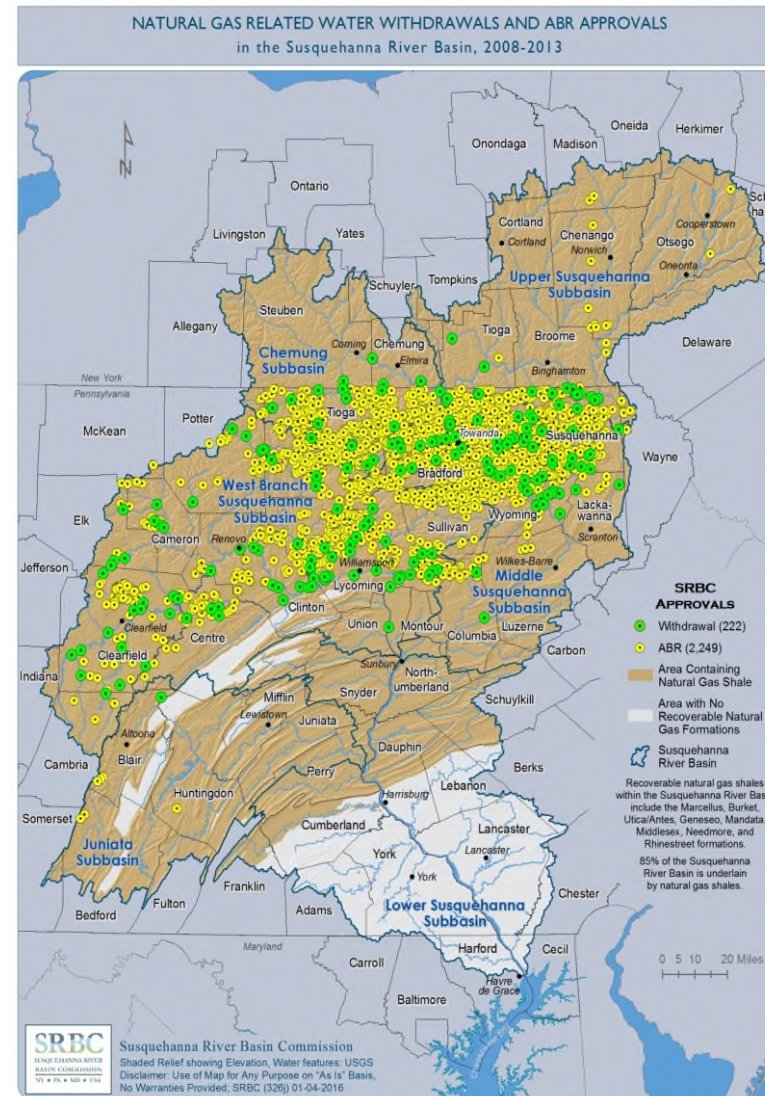


Marcellus Shale/Unconventional Natural Gas Drilling

2009



2013



Remote Water Quality Monitoring Network

- ▶ In 2010, SRBC initiated the RWQMN as a mechanism to continually monitor changes in water chemistry as a response to the rapidly growing Marcellus Shale drilling industry
- ▶ Currently, 59 streams have permanent monitoring stations
 - ▶ temperature, pH, conductivity, dissolved oxygen and turbidity
 - ▶ 15 minute intervals
 - ▶ Reports live to a public website
- ▶ Biological monitoring started in 2011



REMOTE WATER QUALITY MONITORING NETWORK PRIORITY WATERSHEDS IN THE SUSQUEHANNA RIVER BASIN

**Area Containing
Natural Gas Shales**

**Area with No
Recoverable Natural
Gas Formations**

Recoverable Natural Gas Shales within the Susquehanna River Basin include the Marcellus, Burket, Utica/Antes, Genesee, Mandata, Middlesex, Needmore, and Rhinestreet Formations.

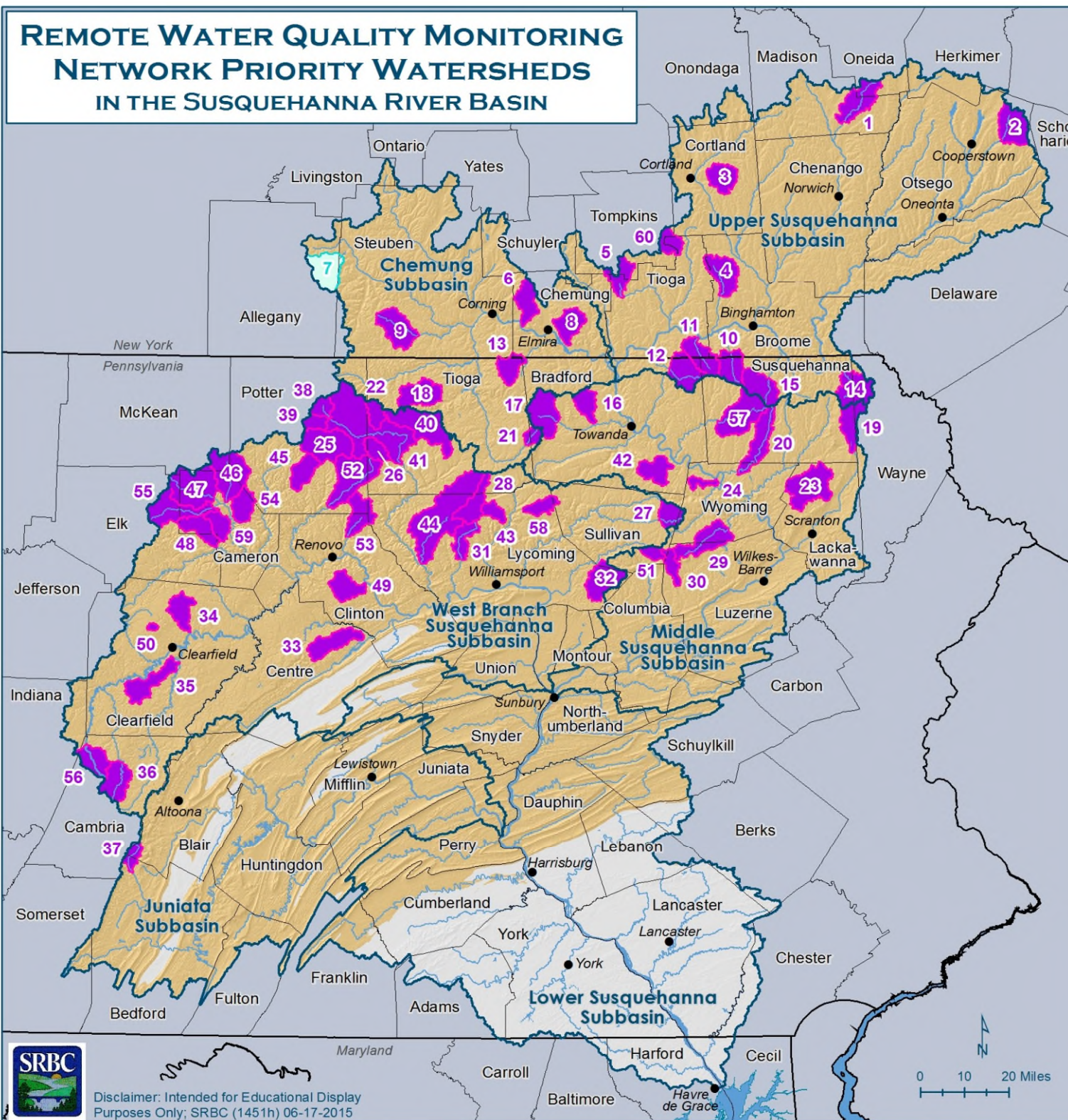
PRIORITY WATERSHEDS

Station Installed

- | | |
|------------------------------------|--|
| 1. Sangerfield River | 32. Little Muncy Creek |
| 2. Cherry Valley Creek | 33. Marsh Creek |
| 3. Trout Brook | 34. Trout Run |
| 4. Nanticoke Creek | 35. Little Clearfield Creek |
| 5. Catatunk Creek | 36. Chest Creek |
| 6. Sing Sing Creek | 37. Bobs Creek |
| 8. Baldwin Creek | 38. Upper Pine Creek |
| 9. Tuscarora Creek | 39. Ninemile Run |
| 10. Choconut Creek | 40. Marsh Creek |
| 11. Apalachin Creek | 41. Pine Creek |
| 12. Wappasening Creek | 42. Sugar Run |
| 13. Hammond Creek | 43. Grays Run |
| 14. Starrucca Creek | 44. Little Pine Creek |
| 15. Snake Creek | 45. East Fork First Fork Sinnemahoning Creek |
| 16. Tomjack Creek | 46. Portage Creek |
| 17. Sugar Creek | 47. Driftwood Branch |
| 18. Crooked Creek | 48. Hicks Run |
| 19. Lackawanna River | 49. Baker Run |
| 20. Meshoppen Creek | 50. Moose Creek |
| 21. Tioga River | 51. East Branch Fishing Creek |
| 23. South Branch Tunkhannock Creek | 52. Kettle Creek |
| 24. Little Mehoopany Creek | 53. Young Womans Creek |
| 25. West Branch Pine Creek | 54. Hunts Run |
| 26. Elk Run | 55. West Creek |
| 27. Loyalsock Creek | 56. West Branch Susquehanna River |
| 28. Blockhouse Creek | 57. East Branch Wyalusing Creek |
| 29. Bowman Creek | 58. Pleasant Stream |
| 30. Kitchen Creek | 59. Sterling Run |
| 31. Larrys Creek | 60. West Branch Owego Creek |

Historical Station

7. Canacadea Creek



Disclaimer: Intended for Educational Display
Purposes Only; SRBC (1451h) 06-17-2015

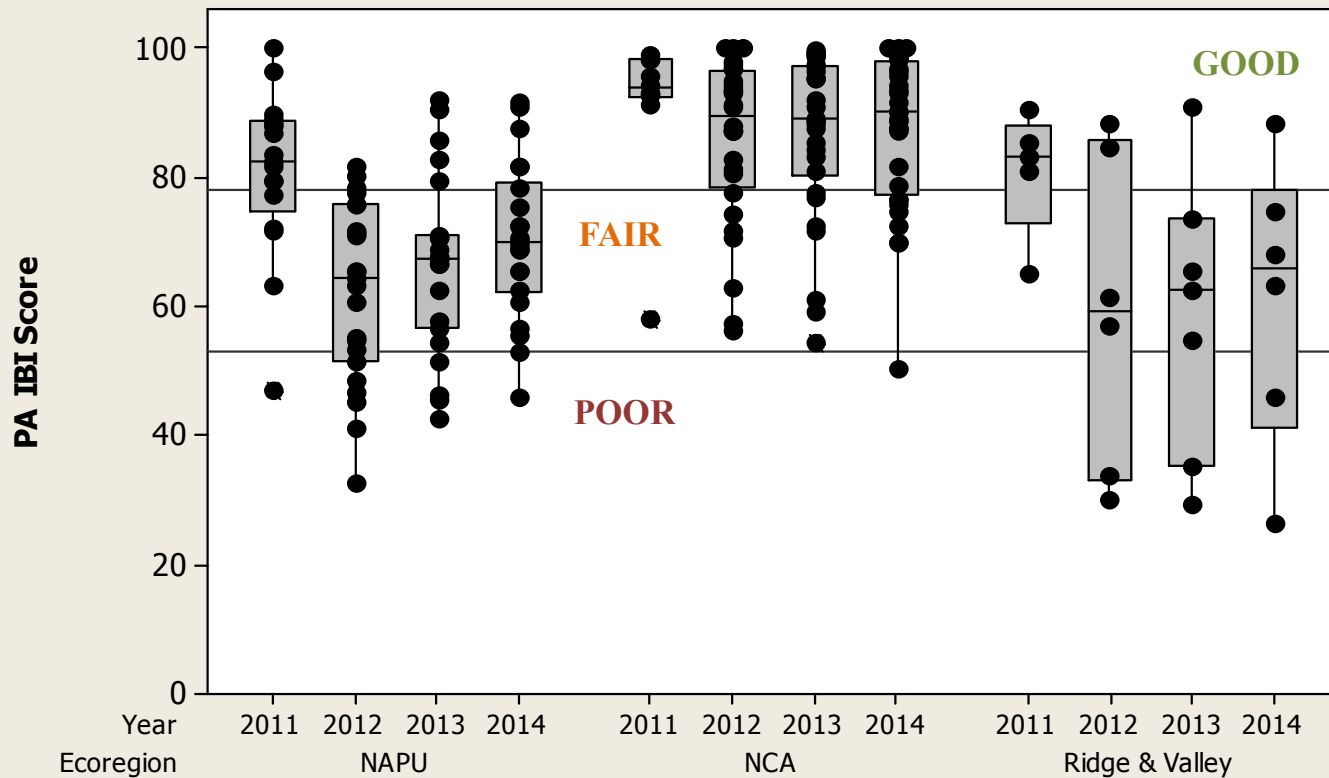
Questions

1. What was the existing condition of macroinvertebrate communities and are those conditions changing over time?
2. Is there any correlation between IBI score and UNG well density?
3. Are the Exceptional Value (EV) and High Quality (HQ) streams within the network still attaining those levels of biological integrity?

Question 1: What was the existing condition of macroinvertebrate assemblages and have they changed over time?

- ▶ Forested land use ranges from 25-99% (mean 75%)
- ▶ Agricultural land use ranges from 3%-55% (mean 20%)
- ▶ Standard PA freestone methods, 6 D-frame kick composite, 200 subsample to genus; PA IBI
- ▶ 215 total samples collected, less than 10% of samples scored below 53 on PA IBI and were considered “poor”
- ▶ Showed that a majority of streams support healthy or at least satisfactory macroinvertebrate assemblages

Comparison of IBI Scores Across Ecoregions, 2011-2014

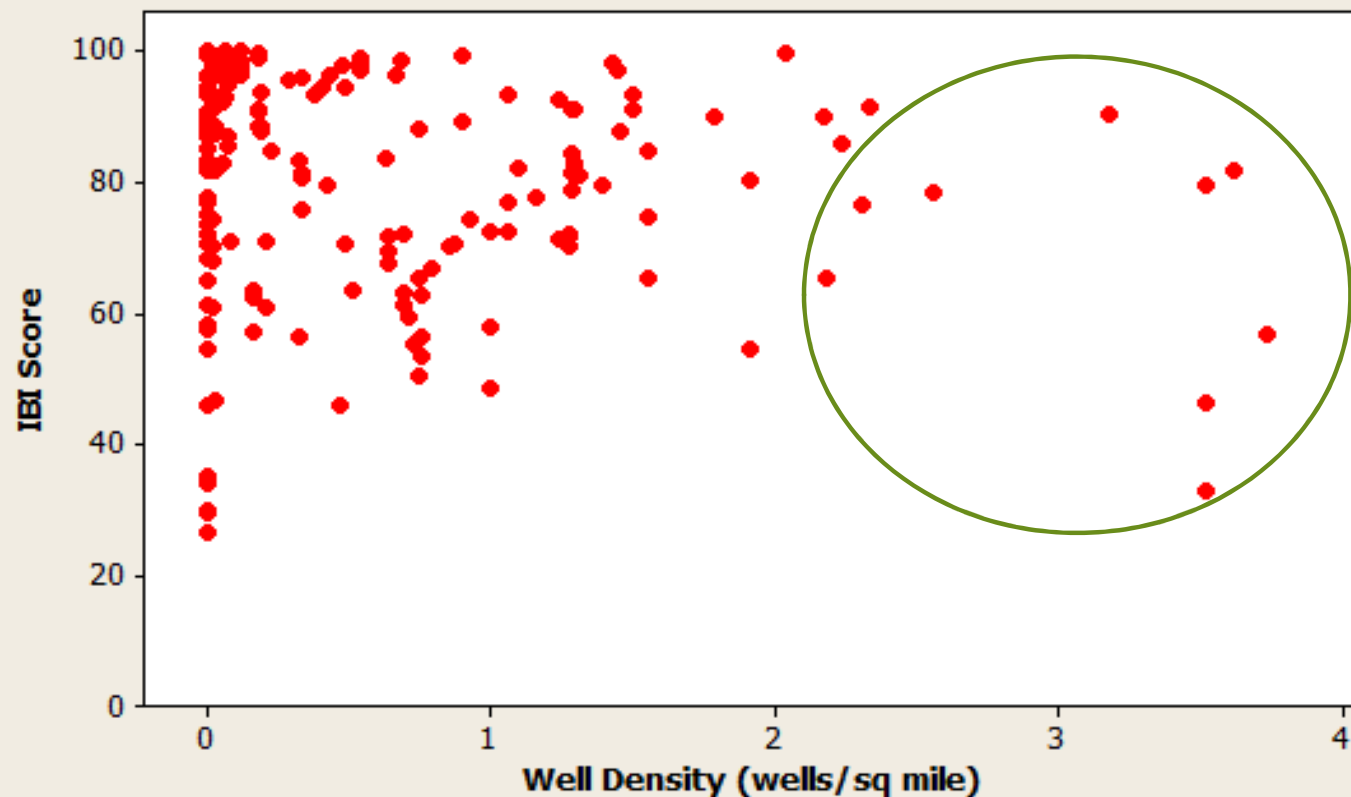


- 2011 samples taken 8 weeks after historic flooding; showed measurably different macroinvertebrates across all sites but particularly the NAPU ecoregion
- Lowest scoring sites often have known impacts; AMD, heavily agricultural or upstream reservoirs

Question 2: Is there any correlation between IBI scores and UNG well density?

- ▶ 85% of basin is underlain with drillable shales (Marcellus primary formation)
- ▶ UNG drilling expanding rapidly since 2009
- ▶ 1650 wells drilled just within these 59 watersheds
- ▶ 19 watersheds have no UNG wells (10 in NY state)
- ▶ Well density ranges from 0 - 3.7 wells/square mile

IBI Score vs. Well Density (PA Only)

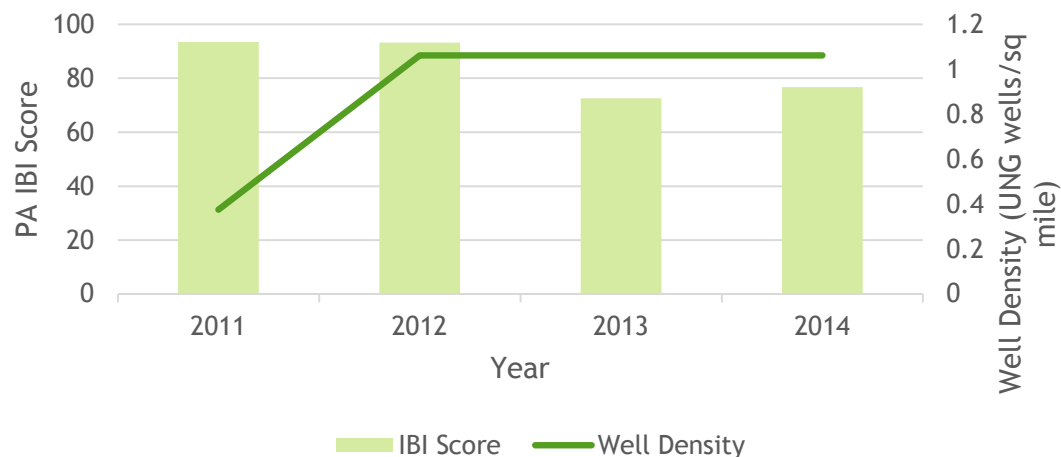


Correlation is
negative
and significant
Pearson $r = -0.163$
 $p=0.026$

BUT same watersheds have high agricultural land use and did NOT have great macroinvertebrate assemblages pre-drilling

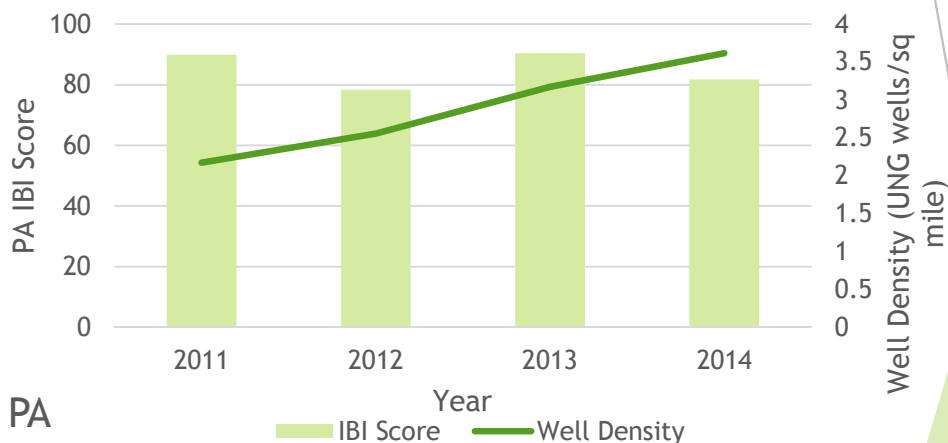
IBI scores more highly correlated to % forest and % agriculture and RBP habitat score than gas well density

Grays Run - Lycoming County, PA

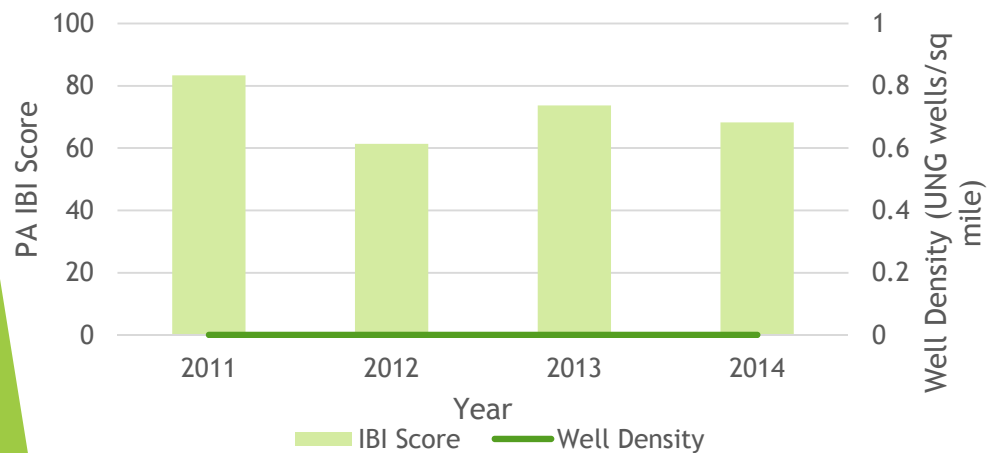


**NO CLEAR
ANSWER**

Meshoppen Creek - Wyoming County, PA



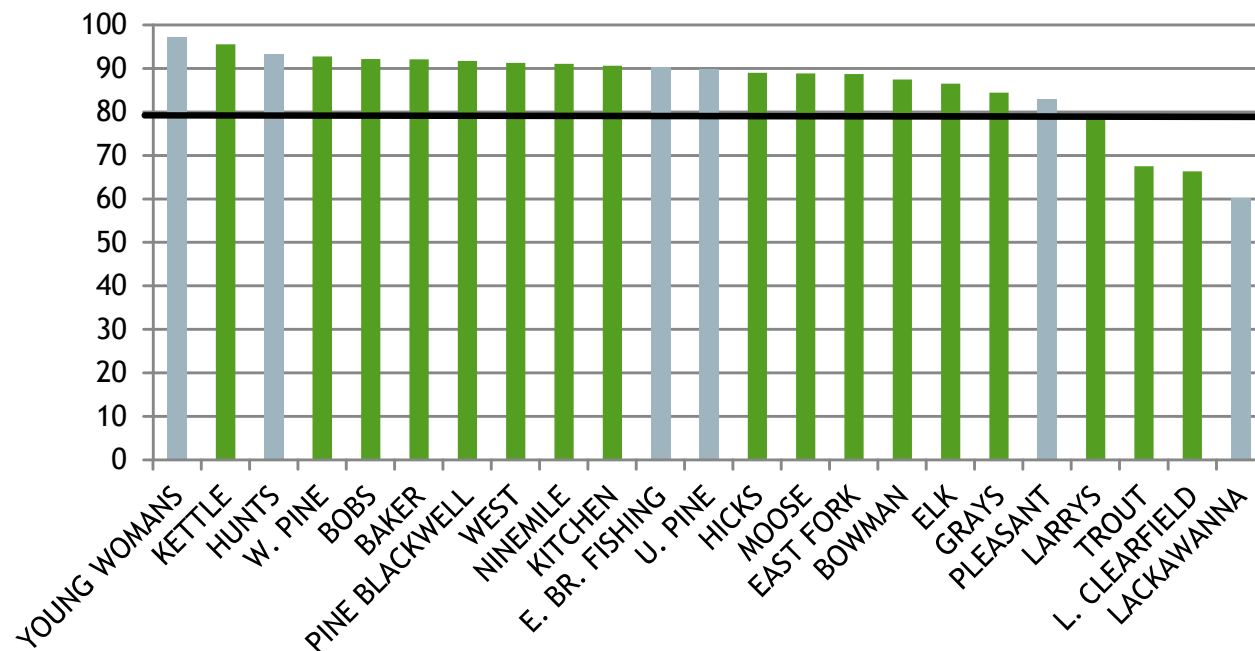
Marsh Creek - Centre County, PA



Question 3: Are the Exceptional Value (EV) and High Quality (HQ) streams within the network still attaining those levels of biological integrity?

- ▶ 2 streams EV, 17 streams HQ
- ▶ Spring Index period 2015 and 2016
- ▶ 13 have active drilling, 6 have no active drilling
- ▶ Evaluated IBI scores, reference metrics and compared to pre-2009 data collected at same sites where available
- ▶ Reference metrics
 - ▶ Taxa Richness
 - ▶ EPT Taxa, PTV 0-4
 - ▶ Hilsenhoff Biotic Index
 - ▶ % Dominant taxa
 - ▶ % Ephemeroptera taxa, PTV 0-4

IBI Scores - 2015 EV/HQ Sites



- ▶ All but 4 sites met the general threshold of 80 on the IBI
- ▶ The same four sites did not meet reference condition ranges for more than one of the five metrics used to evaluate EV/HQ streams
- ▶ Comparison of macro assemblages at these sites in 2015 to older samples collected prior to 2009 revealed no significant changes in assemblage composition
- ▶ No obvious pattern related to drilling and IBI score

But some reference metrics might tell a different story...

1 st Variable	2 nd Variable	Pearson Correlation R	p-value
Taxa Richness	Well Density	-0.162	0.460
EPT Taxa (PTV 0-4)	Well Density	-0.097	0.659
HBI	Well Density	0.227	0.298
% Dominant Taxa	Well Density	0.108	0.625
% Ephemeroptera (PTV 0-4)	Well Density	-0.413	0.050

- ▶ Significant decline in sensitive mayfly taxa with increasing well density
- ▶ Only one year of data - very preliminary
- ▶ Definitely an area of concern in protecting the best streams

Conclusions

- ▶ No measurable consistent decline in macroinvertebrate assemblages across the RWQMN
- ▶ Weak but significant correlation between IBI score and unconventional well density in PA
 - ▶ Difficult to prove causation
- ▶ In the best streams, macroinvertebrate assemblages are by in large maintaining the quality needed to keep their designated special protection.
- ▶ Preliminary data indicate in EV/HQ streams, where land use is primarily forest, a significant correlation exists between declining sensitive mayfly taxa and increasing well density

Future Directions

- ▶ Revised protocol to sampling for at least 2 years during spring index period
 - ▶ Expect more sensitive mayflies
 - ▶ Test preliminary finding in a bigger data set
- ▶ Continue to develop novel ways to better quantify potential impacts from UNG industry
- ▶ Improve knowledge of links and thresholds between water quality and macroinvertebrate assemblages
- ▶ Keep monitoring!

Questions?

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